DAA C2 Assignment-1

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Question -

Given an array of 2n elements in the following format a1, a2, a3, a4, ..., an, b1, b2, b3, b4, ..., bn .

The task is shuffle the array to a1, b1, a2, b2, a3, b3, ..., an, bn without using extra space.

Example -

INPUT :
8
1 3 5 7 2 4 6 8
OUTPUT:
1st iteration: 1 3 2 4 5 7 6 8
2nd iteration: 1 2 3 4
3rd iteration: 5 6 7 8
Final Shuffled Array : 1 2 3 4 5 6 7 8

Some Definitions:-

Divide and Conquer Algorithm:- A divide-and-conquer algorithm recursively breaks down a problem into two or more sub-problems of the same or related type, until these become simple enough to be solved directly. The solutions to the sub-problems are then combined to give a solution to the original problem.

Algorithm Description:-

Here we are using Divide and Conquer Technique.

Firstly we will divide the given array into half and swap second half element of arr1[] with first half element of arr2[]. Recursively do this for both the arrays arr1 and arr2.

Algorithmic Steps:-

- Let us consider an array be {a1, a2, a3, a4, b1, b2, b3, b4} .
- Now split the array into two halves i.e., {a1, a2, a3, a4} ; {b1, b2, b3, b4}.
- Now we will swap elements which are present around the center i.e., we will swap a3, a4 with b1, b2 correspondingly.
- After swapping we will get: a1, a2, b1, b2, a3, a4, b3,b4.
- Now we will recursively split the above subarrays and swap the elements around the center for each subarray.
- Finally we will get a1, b1, a2, b2 and a3, b3, a4, b4.
- Now final shuffled array is{a1,b1,a2,b2,a3,b3,a4,b4}

Pseudo Code:-

```
//Function to shufle an array
void shufflearray(int arr[],int start , int end)
// base condition
if(end < start )then
return ;
//if only two elements present in the subarray
if(end = start + 1)then
return ;
```

Pseudo Code(contd.):-

```
//Finding middle of the array to divide the array
int mid ← (start + end) /2;
//using temp in order to swap first half of second array
int temp ← mid +1;
//using first in order to swap second half of first array
int firstmid ← (start + mid)/2;
//Swapping the center elements
for(i = firstmid +1 to i < = mid )
```

Pseudo Code(contd.):-

```
swap (arr[i],arr[temp++]);
i ← i+1;
// recursively calling the function for first and second subarrays
shuflearray(arr, start, mid);
shuflearray(arr, mid + 1, end);
//MAIN FUNCTION
int main()

    int n =1+(rand())%10;
    cout <<n<<"\n";
```

Psuedo Code(contd.):-

```
  int length=pow(2,n);
  int arr[length];
  for(int i=0;i<length;i++)
   arr[i]=(rand())%100;
for (int i = 0; i <length; i++)
        cout << arr[i] << " ";
cout <<"\n";
  shufleArray(arr, 0, length - 1);

  for (int i = 0; i < length; i++)
        cout << arr[i] << " ";

  return 0;
```

Time Complexity:-

In the above algorithm we get the recurrence

$T(n)=2T(n/2)+O(n)$

for the time complexity, which results in

$T(n)=O(nlogn)$

So the final computational time to shuffle the given array is

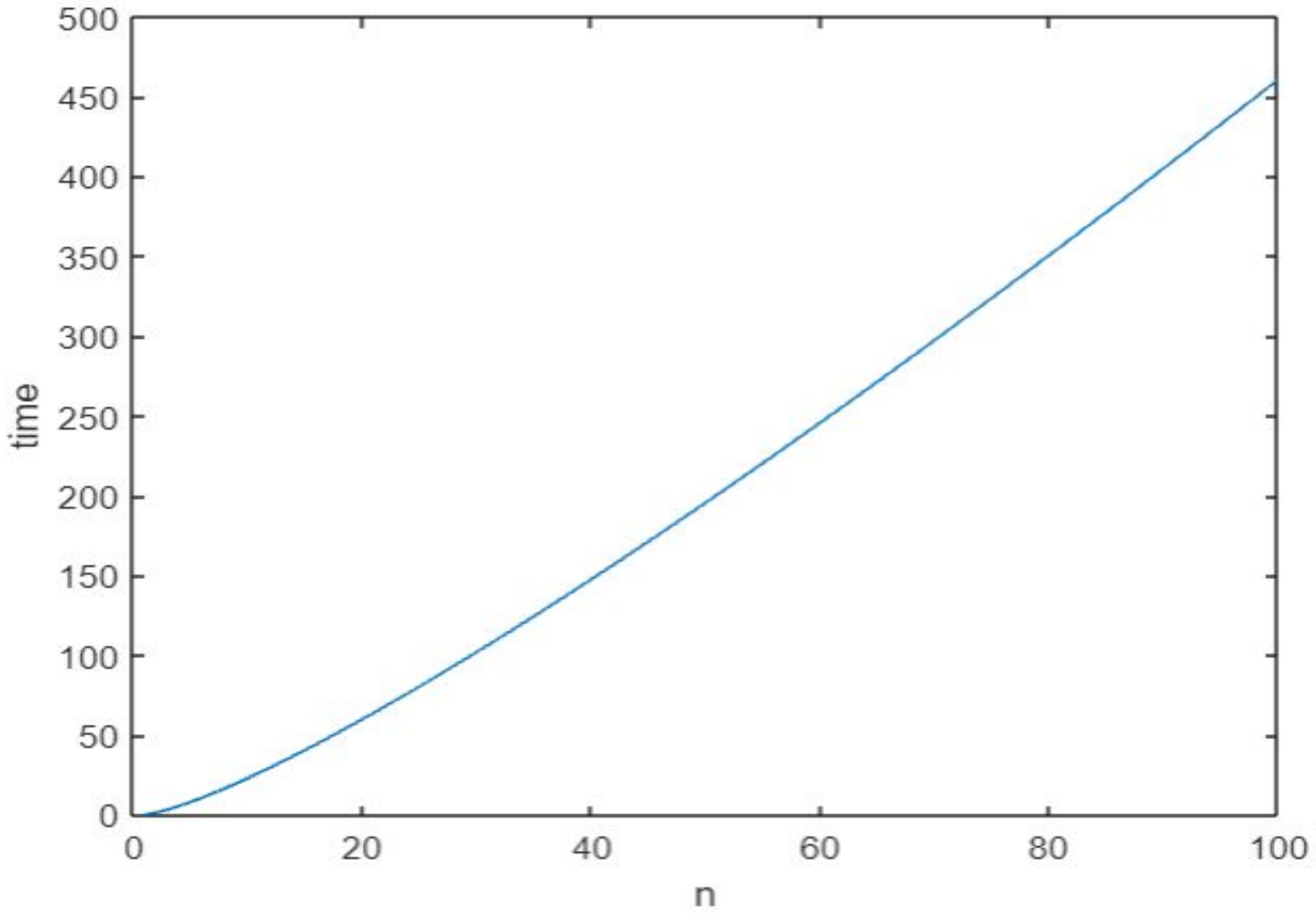
$O(nlogn)$.

Space Complexity:-

To be precise , as we are swapping the elements in the given array itself there is no extra space required.

So the space complexity will be O(1).

Time Complexity Graph(O(nlogn)):-



Conclusion:-

Hence, from the above graph and analysis, we come to the conclusion that this problem can be solved using the time complexity of O(nlogn) and space complexity of O(1).

References:-

1) Introduction to Algorithms by Cormen,Charles,Rivest and Stein.
2) Geeks for Geeks.

Thank You